AN EXAMINATION OF THE INFLUENCE OF THE ILIO-PSOAS MUSCLE UPON THE ROTATION OF THE THIGH.

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THE ilio-psoas muscle flexes the thigh upon the pelvis or the pelvis upon the thigh; it approximates the bone to the median line of the body or adducts the thigh; it rotates the femur about a vertical axis. Thus far are anatomists agreed. Until recently the statement of the standard text-books that the muscle in question rotated the thigh-bone outward has stood unchallenged, and at the present time is supported by such authority as Gray, Holden, Macalister, Owen, McClelland and Ranney, as well as many others. The last edition of Quain seems to be silent upon this particular phase of its action. J. H. Davies-Colley, however, writing in the recent text-book known as Morris' Anatomy, throws down the gauntlet to the generally accepted theory in the following words (p. 366): "It has been sometimes described as an external rotator of the hip; and its insertion into the lesser trochanter at the inner side of the femur would appear to favor this view; but a little consideration will show that, although it is attached on the inner side of the femur, yet, on account of the angle which the neck of the femur forms with its shaft, this point of attachment is really external to the axis about which the rotation of the femur takes place. It will follow, therefore, that any power of rotation exercised by this muscle will be rather internal than external."

The editor, Dr. Morris, discussing the anatomy of the joints in the same work, apparently disagrees with his collaborator, for,

by way of indirect contradiction, at least, he says (page 270; italics supplied): "Adduction and inward rotation are very limited in the extended thigh; adduction on account of the contact with the opposite limb; the inward rotation, because *all the muscles of internal rotation (save the tensor vaginæ femoris) are also extensors*, whereas most of the other extensors are also outward rotators, so that each set requires to be relaxed by flexion before inward rotation can be perfected."

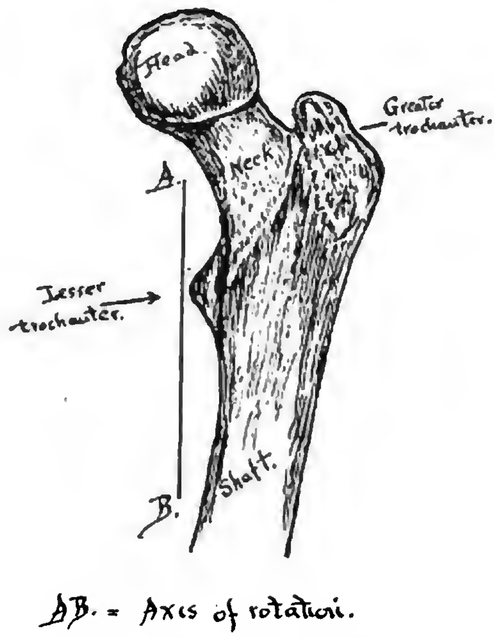

FIG. I.—Showing axis of rotation of femur.

In order that the subject may be more fully understood, it may not be improper to call attention to a few points connected with the anatomy of the hip joint and of the ilio-psoas muscle. The head of the femur forms about three-fifths of a sphere, and is embraced by the cavity of the acetabulum and its fibro-carti-

laginous rim, the so-called cotyloid ligament. So far as the principle of mechanics involved is concerned, it may be considered as a complete sphere enclosed in a shell which is exactly applied to its surface, and within which it moves in every direction around a centre, which is the centre of the sphere itself. That only parts of the spherical surface and of its cavity of reception are covered by articular cartilage, as well as of the existence of certain

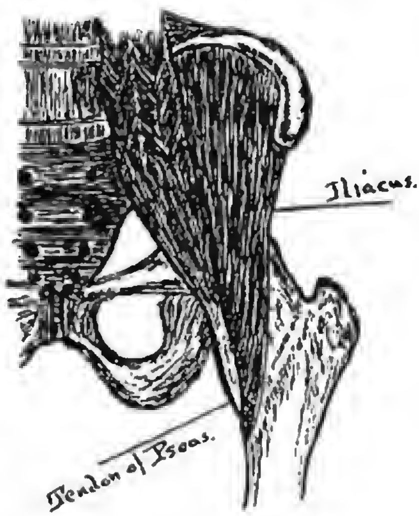

FIG. 2.—Showing relation of ilio-psoas muscle to femur.

inequalities around the dimple, may be explained by the fact that the latitude of the various motions of the joint is limited either by the tension of its ligaments or the approximation of surrounding parts. The spherical head is supported upon a stout pyramidal process called the neck, flattened somewhat in its antero-posterior diameter, having an upper border about an inch in length, looking somewhat forward, and a lower border about an inch and a half in length, looking somewhat backward. It joins the shaft at an angle of about 125°. Inasmuch as the femur is

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inclined obliquely inward, the line of gravity falling through the centre of the head and the external condyle, the inclination of the neck to a perpendicular is increased to about 140°. The neck also juts forward at an angle of about 15°, so that the head of the femur is in a plane anterior to that of the shaft.

It will thus be seen that the head of the femur in articulating with the acetabulum, looks upward, inward and forward. The lesser trochanter is developed at the union of the shaft and the lower border of the neck, and, therefore, lies in a plane posterior to the head.

The ilio-psoas is made up of two parts, sometimes described as distinct muscles; the iliacus and psoas magnus. Both arise within the pelvis and their fibres, converging, pass out under Poupart's ligament, across the horizontal ramus of the pubes, just internal to the pectineal eminence. The iliacus, lying to the outer side, is inserted, principally, into the tendon of the psoas, which, in turn, is inserted into the lower and back part of the lesser trochanter. A few fibres of the iliacus pass to an independent insertion into a line or ridge just below and somewhat anterior to the trochanter. After crossing the pelvic brim the ilio-psoas changes its direction, passing downward, backward and outward to its insertion, and, from a mechanical standpoint, this is the only part of the muscle to be taken into account in studying its action upon the movements of the femur. It must also be borne in mind that the line of gravity of the femur coincides with the radius of its motion in flexion and adduction and is the axis about which it rotates.

As the muscle contracts, its origin being its fixed point, the femur is undoubtedly flexed, adducted and rotated at the same time, and, to properly study its influence upon rotation, this complex motion must be analyzed and the factors of flexion and adduction eliminated. The downward inclination of the tendon is prejudicial to every action of the muscle upon the joint, and is one of necessity only, so to speak. Its backward inclination influences flexion, the lesser trochanter describing the arc of a circle forward in an antero-posterior plane. Its outer inclination influences adduction, the trochanter describing the arc of a

circle inward in a transverse plane. Both of these planes are vertical, and the radii of the arcs are equal to the vertical distance between the centre of the head of the femur and the point of attachment of the ilio-psoas tendon.

In the rotation of the femur the lesser trochanter also describes the arc of a circle. The radius of this arc, however, moves in a horizontal plane, passing through the lesser trochanter, and the centre of the circle is the point where this plane is intersected by the axis of the rotation of the femur.

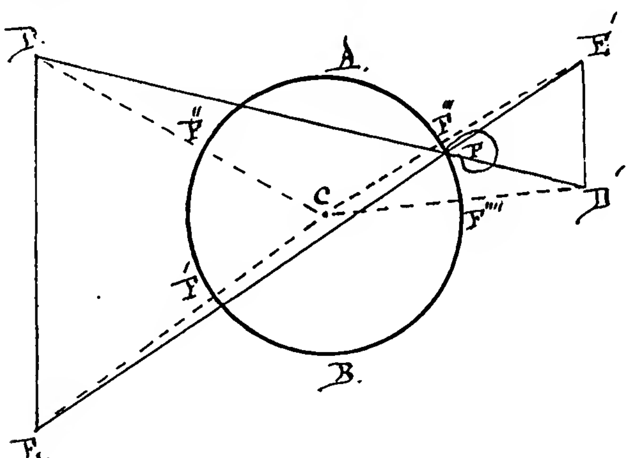

Fig. 3.

Let Fig. 3 be supposed to represent a horizontal plane passing through the body, at the level of the lesser trochanter; F, the femur; D E, a line drawn antero-posteriorly through the median line of the body; C, the point where the plane is intersected by the axis of rotation of the femur. It will appear quite evident that traction upon F in the direction of the line E F would draw it toward the point B, and pass it to the point F′, which is situated in a line between C and E. That is, it would rotate the femur inward. If, however, traction were to be made in the direction of the line D F., the trochanter would move

toward A and pass it to F″. That is, it would rotate the femur outward.

The following rule may, therefore, be formulated, viz.: All muscles attached to the femur, which have their fixed point internal to the axis of rotation, rotate the bone internally, provided the line of traction, or such line extended, passes anterior to such axis. If the line of traction passes posterior to such axis, the rotation will be external.

By reference, again, to the figure, let the line D′ E′ be drawn external to the femur, and it is evident, with respect to muscles arising therefrom, that the rule would be reversed. Whether or not, then, the ilio-psoas is an internal rotator, the reason alleged in support of the proposition in Morris' Anatomy is insufficient.

As an argument in support of the action of this muscle as an internal rotator, Dr. Jarvis S. Wight, of Brooklyn, alleges that in examinations made upon the cadaver, forcible external rotation of the thigh makes tense its tendon, and, conversely, it is relaxed by internal rotation. This would seem to be a most practical demonstration of the truth of his theory, provided he had carefully eliminated the motions of flexion, extension or adduction from the problem.

The writer of this article is inclined to believe that Dr. Wight experimented upon the joint in the extended or over-extended position of the thigh, since, under such conditions, he has obtained similar results, but he is, also, from repeated experiments, as certainly convinced, that in the flexed position the tendon is made tense by internal rotation and relaxed by the opposite motion. Since in extension the head of the femur is firmly held in its socket by the tension of the capsule, and in flexion the ilio-psoas tendon is relaxed, the above demonstrations are somewhat difficult to make, but not sufficiently so but that it is plain that in the extended position what rotation does occur through the influence of the ilio-psoas, is internal, and in the flexion of the thigh, especially if accompanied with adduction, external rotation is marked.

To apply the mechanical principles hereinbefore set forth to the case in question, certain measurements have been made with

the thigh extended, and it is found that a point at the lower part of the lesser trochanter is distant nine-tenths of an inch from the axis of rotation of the femur; that it is six-tenths of an inch external and seven-tenths of an inch posterior thereto. This represents the point of attachment of the ilio-psoas tendon. The fixed

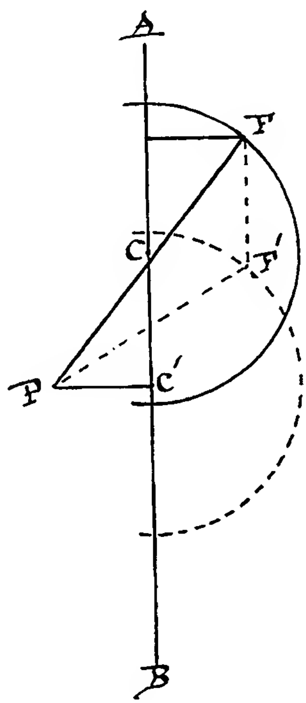

FIG. 4.

point from which traction is made may be taken as situated upon the anterior margin of the horizontal ramus of the pubes, just internal to the pectineal eminence. This point is six-tenths of an inch internal and eight-tenths of an inch anterior to the axis of rotation of the femur.

If, now, these points be projected upon a plain surface, and C be the axis of rotation, F the attachment of the tendon to the femur, and P the fixed point of traction (as in Fig. 4), the line will pass in front of the centre of rotation, and internal rotation be the result.

But in mid-flexion C will be found in a line with P at C′, having swung forward along, A B, an antero-posterior arc. The line of traction, P F′, now passes posterior to the centre of rotation at C′, and the action is that of external rotation.